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A New Reflective Optical eXtensometer (ROX) System For Geomechanical Deformation Measurements.

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An optical extensometer has been developed for measurement of distance and displacements in underground environments. In this design, reflecting targets are placed at desired measurement locations and distance between each target and an optical head are measured repeatedly using a modulated laser beam. We have used the ROX methodology to construct an Optical-multi-point borehole extensometer (MPBX) that is now in use at Yucca Mountain, Nevada. The instrument has 3 major components: (1) a computer controlled distance measuring module that contains a laser distance measuring instrument and an optical switching system, (2) a borehole head that is connected to the distance measuring module using optical fibers, and (3) downhole targets (anchors) that contain retro-reflectors. A system schematic is shown in Figure 1, and Figure 2 presents a photograph of the distance measuring module, borehole head and a downhole retro-reflector. This system has many advantages over conventional MPBX systems. First, because the signal is transmitted over optical cables, electrical noise and resistance are eliminated. Moreover, the system is inherently reliable as all electronic and moving parts are located outside of the borehole environment.

This system can be used to make measurements over distances of a few centimeters to several tens of meters, and has a theoretical accuracy of 56 microns. In addition, this accuracy is the same whether the measurement is over a few cm. or a few tens of meters. We are currently using this system to monitor deformation in two boreholes located in the Single Heater Test now being conducted in the Exploratory Studies Facility at Yucca Mountain, for the Yucca Mountain Site Characterization Project. The Single Heater Test is now just underway and only limited data are available. However, by the time of submission of the paper for this meeting, approximately 5 months of data from the ROX system will be available, and will be included and discussed in the paper.

In addition, we have developed a system for emplacing, positioning, and retrieving retro-reflectors (and other anchors) in wells and boreholes. The system provides a method for the rotational orientation of the anchors. This is accomplished by locating a mercury switch on the installation tool. Once the anchor is at the desired depth in the hole, it is rotated until the switch indicates that it is properly located. The installation tool can also be used to retrieve the anchors.

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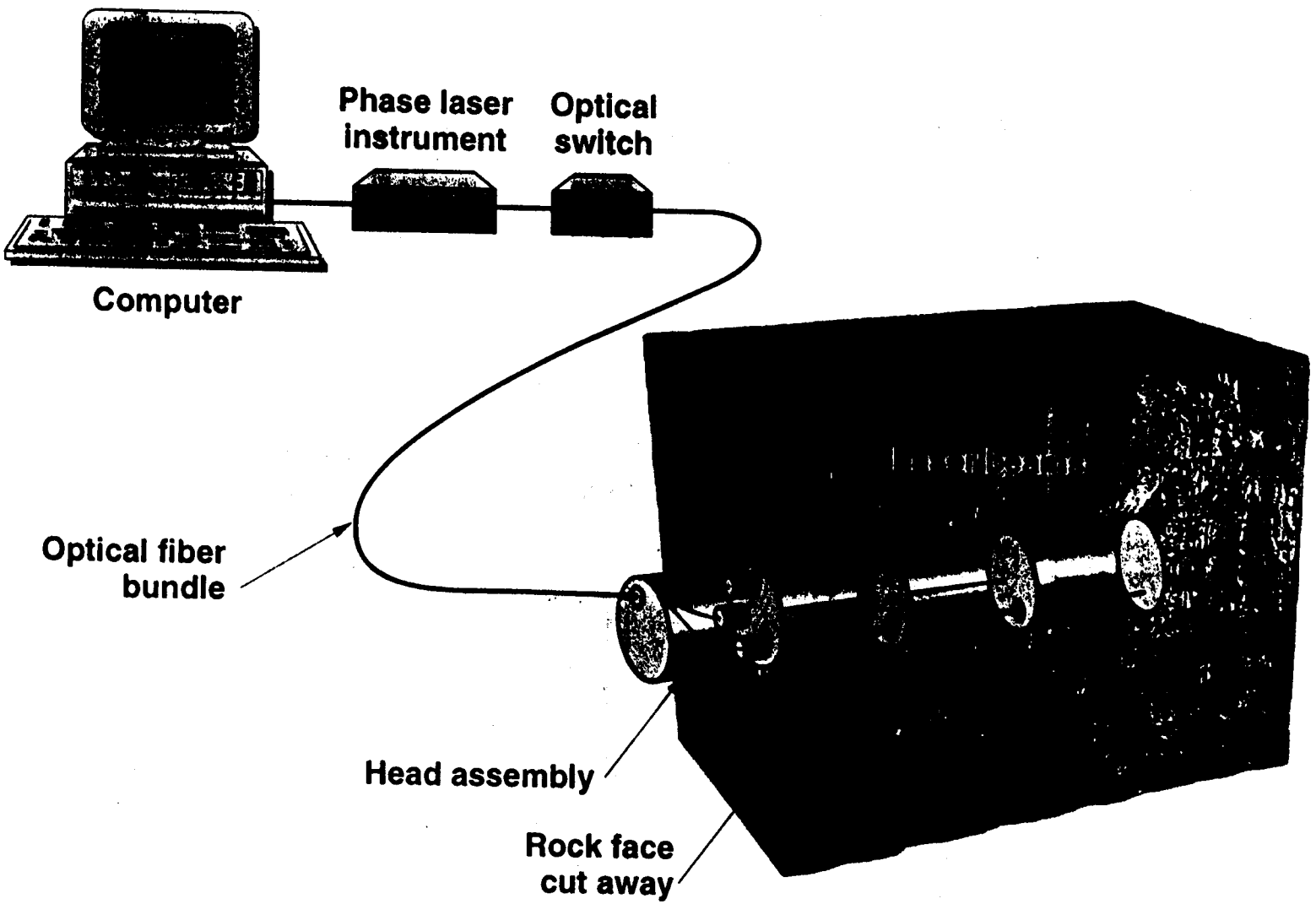

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Figure 1. Schematic of ROX System.

Figure 2. Photograph of ROX Hardware.